The use of hydroelectric lakes by giant otters *Pteronura brasiliensis*: Balbina lake in central Amazonia, Brazil

Fernando C.W. Rosas, Gália Ely de Mattos and Márcia Munick Mendes Cabral

Abstract Data on the occurrence and habitat use of giant otters *Pteronura brasiliensis* in the 4,437 km^2 of Balbina hydroelectric lake in central Amazonia, Brazil, were collected from September 2001 to December 2005. Twenty-nine groups of giant otters were recorded in an area corresponding to 10% of the total reservoir. Despite the fact that it is a hydroelectric lake, the water level can vary annually by up to 3.5 m with the Amazonian seasonal flood pulse. A total of 210 dens, communal latrines and campsites of giant otters were located. An average of 37% of the dens observed were classified as in use, and the species was recorded in the lake throughout the year. Giant otters started their daily activities between 05.23 and 08.05. The average height of den openings was 28.77 ± SD 10.00 cm, with an average width of 56.11 ± SD 19.17 cm. Births in Balbina occur mainly during the period of high and receding water level, as reported for giant otters in other Amazonian areas. There are at least two conditions that enable the species to inhabit hydroelectric reservoirs: (1) presence of the species in the area before dam construction and (2) absence or low numbers of human communities around the reservoir. The potential use of hydroelectric lakes for the conservation of the giant otter in the Amazon is discussed.

Keywords Amazonia, Balbina hydroelectric lake, Brazil, giant otter, habitat use, *Pteronura brasiliensis*.

Introduction

The giant otter *Pteronura brasiliensis* is a semi-aquatic mammal historically distributed from Guyana, across Venezuela and Colombia, and south to northern Argentina and west of the Andes (Carter & Rosas, 1997). The species is gregarious and territorial, forming family groups of 2-16 individuals that guard and defend their territories, which are regularly marked using faeces and urine in several communal latrines within the family's range (Duplaix, 1980; Carter & Rosas, 1997).

Giant otters are categorized as Threatened on the IUCN Red List (IUCN, 2006), with some southern populations extinct or Critically Endangered (Carter & Rosas, 1997). The main factor responsible for the species' decline is that, until the middle of the last century, it was hunted for its pelt (Best, 1984; Carter & Rosas, 1997; Rosas, 2004). Giant otters are no longer killed for this purpose and the species is protected by national laws in the majority of the countries where it occurs (Carter & Rosas, 1997). However, habitat destruction, mining activities, oil and natural gas exploration, industrial pollution, and the theft of cubs to be sold as pets constitute additional threats to giant otters (Rosas, 2004). Although hydroelectric dams are probably geographical barriers for Amazonian aquatic mammals such as dolphins and manatees, isolating populations genetically (Rosas *et al.*, 1991), this does not seem to be the case for giant otters.

Studies of habitat use by the giant otter are scarce and limited to a few specific places (Duplaix, 1980; Laidler, 1984; Schweizer, 1992; Schenck, 1999). In 2001 we obtained reports that giant otter groups had been observed in Balbina hydroelectric lake (S.M. Lazzarini, pers. comm.). The giant otters' ability to inhabit such lakes was previously unknown and the characteristics of these habitats used by the species in Brazil had not been studied. Here we examine the occurrence and use of Balbina lake by giant otters and discuss the conditions that appear to allow the species to use such habitats, as well as the potential use of these reservoirs for the conservation of the giant otter in the Amazon.

Study area

The data were obtained from systematic observations of resident groups of giant otters in the reservoir of Balbina Hydroelectric Power Plant (Fig. 1). This dam was built on the Uatumã River, a tributary of the north-west Amazon, and is 150 km from the city of Manaus, the capital of Amazonas state, in Central Amazonia, Brazil.

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The Balbina sluice bases were closed in October 1987, and the lake took *c*. 16 months to fill until reaching the 50.6 m spillway level. The higher areas of land resulted in the formation of *c*. 3,300 islands. Current data obtained by the National Institute of Spatial Research (INPE) based on satellite images indicate an estimated flooded area of 4,438 km^2 at the 51 m spillway level (FUNCATE/INPE/ANEEL, 2000), representing an area 88% greater than the value quoted by the electricity agency of northern Brazil (ELETRONORTE, 2005). Despite being a hydroelectric lake, the water level variation in the reservoir, which is measured daily at the hydro plant wall, follows a similar pattern to that of the rivers in central Amazonia, although on a smaller scale, enabling the definition of four hydroclimatic seasons: low water level (December-February), rising water level (March-May), high water level (June-August) and receding water level (September–November; Sioli, 1984).

Methods

The data were collected between September 2001 and December 2005 using an 8 m boat with a 40 HP outboard engine. In total we examined *c*

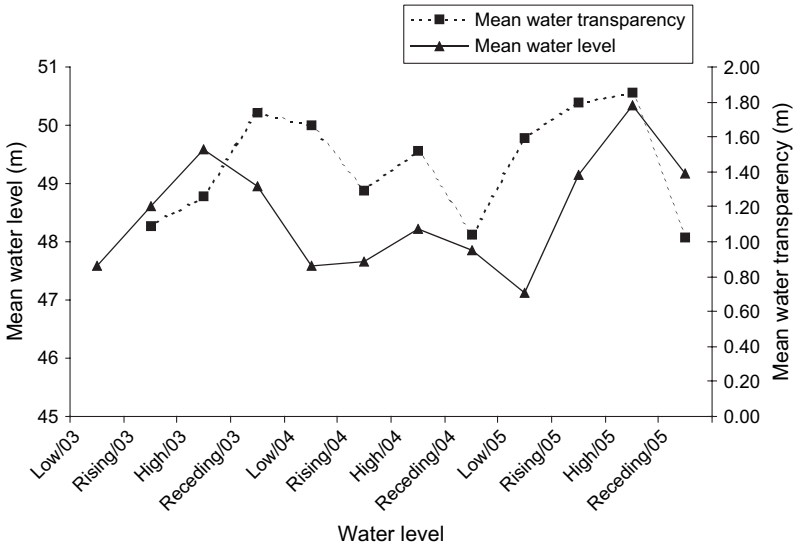

Fig. 2 Mean water level (m) and mean water transparency (m) of Balbina lake during 2003 and 2005.

systematically. To record behaviour patterns and group dynamics we studied the upper portion of the lake, in the area of the Pitinga River, where navigation is easier and where some giant otter groups became habituated to our presence. We recorded the location of dens with a global positioning system (to an accuracy of ± 12 m) and classified them as 'in use' and 'not in use', taking into consideration soil humidity in the surrounding area, occurrence of trampled vegetation, footprints, fresh faeces in nearby communal latrines, and/or presence of the animals in front of the den (Groenendijk *et al.*, 2005). Animals were recognized using their individual neck marks. More than one animal seen together was characterized as a group. Groups were distinguished by using the individual neck marks and by location. Some dens classified as in use were monitored before dawn, and again at dusk, to determine the time giant otters leave and return. The dimensions of the entrances of some dens classified as in use were measured and their shapes recorded. Water transparency was recorded using a Secchi disk in front of several randomly chosen dens.

Results

One hundred and thirty individual giant otters were identified in Balbina lake, in 29 groups. Mean group size was 4.14 (maximum group size = 12 individuals) and there was no apparent change in group size with season. Water level varied annually by up to 3.5 m, and the mean water transparency was 1.02-1.85 m (range 0.35-3.40 m), with the high values recorded during the high water period of 2005 (Fig. 2). Of 210 dens, communal latrines, and campsites recorded, 37% were categorized as in use throughout the study period, and the species was recorded in the lake throughout the year, regardless of the water level. Those dens recorded as in use 40% or more of the time during the study period are shown in Fig. 1. Reproduction appears to be seasonal, with the majority of births occurring between July and December, corresponding to the high and receding water levels.

Giant otters started their morning activities between 05.23 and 08.05 (n = 44). The difficulty of navigating among the dead trees of the flooded forest during the night limited the time we could spend close to the otter dens at the end of the day to record the time of the animals' return but we recorded times of 15.45–18.21 (n = 18).

The predominant soil types of the riverbanks in Balbina reservoir are the ultisols, acid and deep or moderately deep, and oxisol, acid and with a low natural fertility (ELETRONORTE, 2005). The giant otter den openings had an average height of 28.77 ± SD 10.00 cm (range 16-58 cm; n = 49) and an average width of 56.11 ± SD 19.17 cm (range 22-105 cm; n = 49), and were oval, round or elongated in shape.

Discussion

The concentration of *P. brasiliensis* dens in use in the upper part of the surveyed area (Fig. 1) is probably because the influence of the dam is less there than elsewhere, and the margins of this part of the lake are probably similar to how they were before damming. Most of the observations were carried out in this area of the lake because it is easier both to navigate and observe giant otter dens there than in the lower part of the lake. Nevertheless, at least 10 giant otter groups and their dens and campsites were monitored in other parts of the lake, and these are also resident groups. Although some dens are frequently used (40% or more of the time; Fig. 1)

there also appears to be a high turnover rate of dens, probably caused by water level variation, habitat availability, and the presence of predators such as jaguars. New giant otter den entrances are usually smaller than those of older dens, as constant use tends to increase their size (Duplaix, 1980; Schweizer, 1992). However, it is difficult to determine by size alone whether a den is in fact new as opposed to in use or not.

The seasonality of giant otter births in Balbina lake, occurring mainly during the periods of high and receding water, corroborates the data presented by Duplaix (1980) and Laidler (1984) for giant otters in habitats with little or no human interference and seems to be an intrinsic characteristic of the species in the Amazon region. During these periods it is easier for giant otters to move in the flooded forest areas and prey on fish, and therefore meet the high nutritional and energetic requirements of giant otter females at the end of gestation and beginning of lactation.

The high number of giant otters observed in Balbina and the use of the lake throughout the year suggest that hydroelectric lakes have potential for the conservation of the species, in contrast to previous beliefs (Rosas *et al.*, 1991). However, the use of reservoirs by giant otters appears to depend on at least two conditions: (1) the presence of the species in the area prior to the formation of the lake, and (2) reduced human presence after the formation of the lake. It is known that giant otters occurred in the Uatumã River before the dam was built (Colares, 1988) and there are few human communities in the area. All the flooded area of the reservoir on the left bank of the Uatumã River is a Biological Reserve (ReBio Uatumã). By Brazilian law human inhabitants are not allowed in biological reserves and therefore ReBio Uatumã appears to have been fundamental for giant otter conservation. Although the period in which giant otters established their new territories on the lake is unknown they appear to have benefited from the *c*. 3,300 islands that were formed by the creation of the lake. All the dens, communal latrines, campsites and territories previously used by giant otters were submerged during the formation of the lake and those that survived probably moved to the headwaters of the Uatumã River basin. Before the damming, giant otters only had the Uatumã River and its tributaries available for dens and territories. With the flooding and the formation of new islands, the land accessible for giant otters increased greatly, presumably allowing the otter population to expand.

Although the giant otter occurred in the Curuá-Una River and its tributaries before the reservoir formation of the Curuá-Una Hydroelectric Dam (near Santarém City, Pará state, Brazil) the lake has never been used by giant otters (F. Rosas, pers. obs.). It is possible that the absence of giant otters is related to the small size of the Curuá-Una lake (86 km^2) but probably the main factor that prevents use by the giant otter is the density of humans in the area (*c*. one community per 8 km^2 of the lake). In addition, there are no islands in Curuá-Una lake and giant otters would therefore only have the reservoir edges for their dens and territories.

Turning a water body from a lotic to a lentic system by damming a river causes many disturbances. During the early years of the formation of Balbina lake hydrogen sulfide gas from leaf decomposition of the permanently flooded trees reduced concentrations of dissolved oxygen (Fearnside, 1989). However, the transparency of the water increased, thereby benefiting giant otters because they are generally visual predators (Rosas *et al.*, 1999). In the first years after damming any river in the Amazon region, predatory fish (such as peacock basses *Cichla* spp. and piranhas *Serrasalmus* spp.) tend to predominate (Leite & Bittencourt, 1991), and preliminary data indicate that giant otters are consuming 8.5% more piranhas in Balbina lake than in other areas of Amazonia (Rosas *et al.*, 1999). All these factors are, however, common to most of the hydroelectric lakes in the region but the specific conditions of Balbina reservoir (previous presence of the species in the area and absence of inhabitants around the lake) seem to have facilitated the expansion of the giant otter's population following damming.

All identified giant otter groups in Balbina were observed throughout the study period and are therefore resident. Although solitary otters were seen, some of them belonged to family groups that sometimes split up during the day but reunited in the evening to sleep in the same den. This behaviour makes it difficult to identify temporarily solitary animals from actual transient individuals. However, the high number of giant otters in Balbina indicates the capacity of the species to adapt to the new conditions imposed by river damming. Nevertheless, in order to determine the real potential of hydroelectric power stations for the conservation of giant otters in Amazonia, medium- or long-term studies of this species in other reservoirs are required.

Our study of the giant otter in Balbina reservoir continues and is now focusing on behaviour, group dynamics, reproduction, diet and habitat use. Similar studies have been conducted in other Amazonian areas without hydroelectric influence to make comparisons that will provide information for the conservation of this Threatened species.

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Biographical sketches

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